BIOLOGICAL EVALUATION OF GYPSY MOTH

at

Great Falls National Park

2001

Prepared by

Karen D. Felton
Biologist
and
Bradley P. Onken
Entomologist

USDA Forest Service
Forest Health Protection
Morgantown, WV 26505

December 2001

ABSTRACT

On December 5, 2001, USDA Forest Service and USDI Park Service personnel conducted a gypsy moth egg mass survey at Great Falls National Park. The purpose of this survey was to determine population densities to assess the potential for defoliation and the need for treatment in 2002. Current populations are sufficient to cause heavy (61-100 percent) defoliation on approximately 298 acres at Great Falls NP in 2002. Treatment to prevent defoliation is recommended.

METHODS

The survey method used in this survey was the 1/40th acre plot. Gypsy moth survey plots were randomly selected based upon available host trees (mainly oaks), size of sample area and uniformity between egg mass counts. The plots consisted of a tally of all new (2001) egg masses observed on the overstory trees, understory vegetation, ground litter and duff in an 18.6′ radius sample area. The total number of egg masses observed for each plot was multiplied by 40 to determine the number of egg masses per acre. The survey results were then averaged to estimate egg mass density.

Egg mass length was measured at most of the plots to determine the overall "health" of the existing population and as a measure of egg mass fecundity. The average egg mass length (measured in millimeters) and egg mass density (egg masses per acre) were used to estimate defoliation potential (Liebhold et al., 1993).

RESULTS

The location of the survey plots are shown in Figure 1 and the survey results are summarized in Table 1. Egg mass densities ranged from 0-8,320 and averaged 2,816 egg masses per acre. Average egg mass lengths ranged from 23-36 mm and the overall average for the survey area was 30 mm.

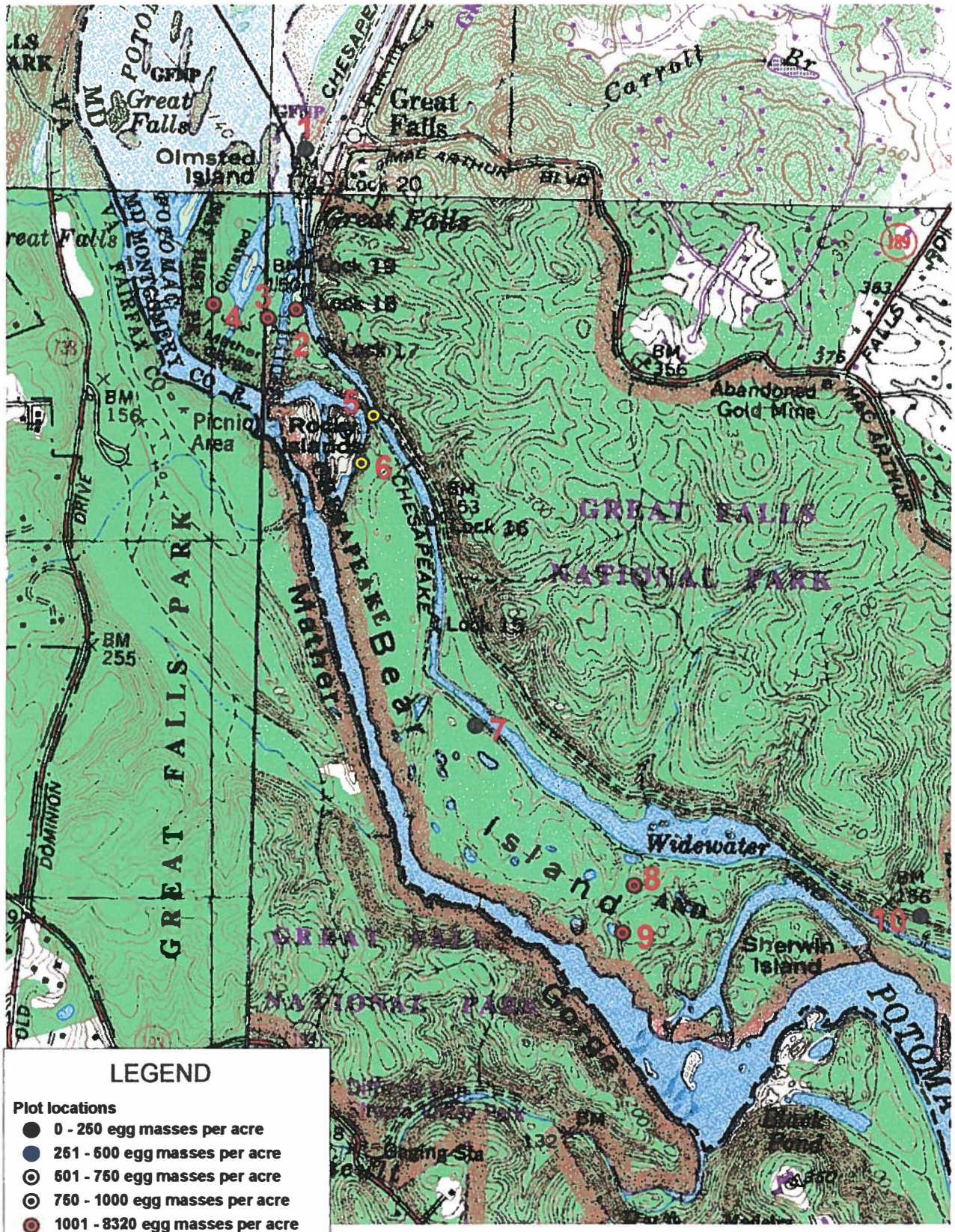
DISCUSSION

The basic guidelines used to evaluate the risk of defoliation include: previous defoliation events; number of egg masses/acre; size and condition of the egg masses; available preferred food (mainly oaks); and risk of larval blow-in following egg hatch. Potential defoliation is categorized as: light (1-30 percent), moderate (31-60 percent), and heavy (61-100 percent).

The survey results indicate that heavy defoliation is likely to occur on approximately 298 acres at Great Falls NP. This area is comprised of Olmsted, Rocky, Bear and Sherwin Islands, and an area along the tow path (Figure 2).

This conclusion is further supported when egg density is used as a means of predicting defoliation. Moore and Jones (1987) found that estimating the mean fecundity would increase the precision of gypsy moth density estimates and that a linear relationship exists between egg mass length and fecundity. Further work by Liebhold et al., (1993) demonstrates that the product

Figure 1.--Gypsy moth egg mass survey plot locations at Great Falls National Park, MD on December 5, 2001.



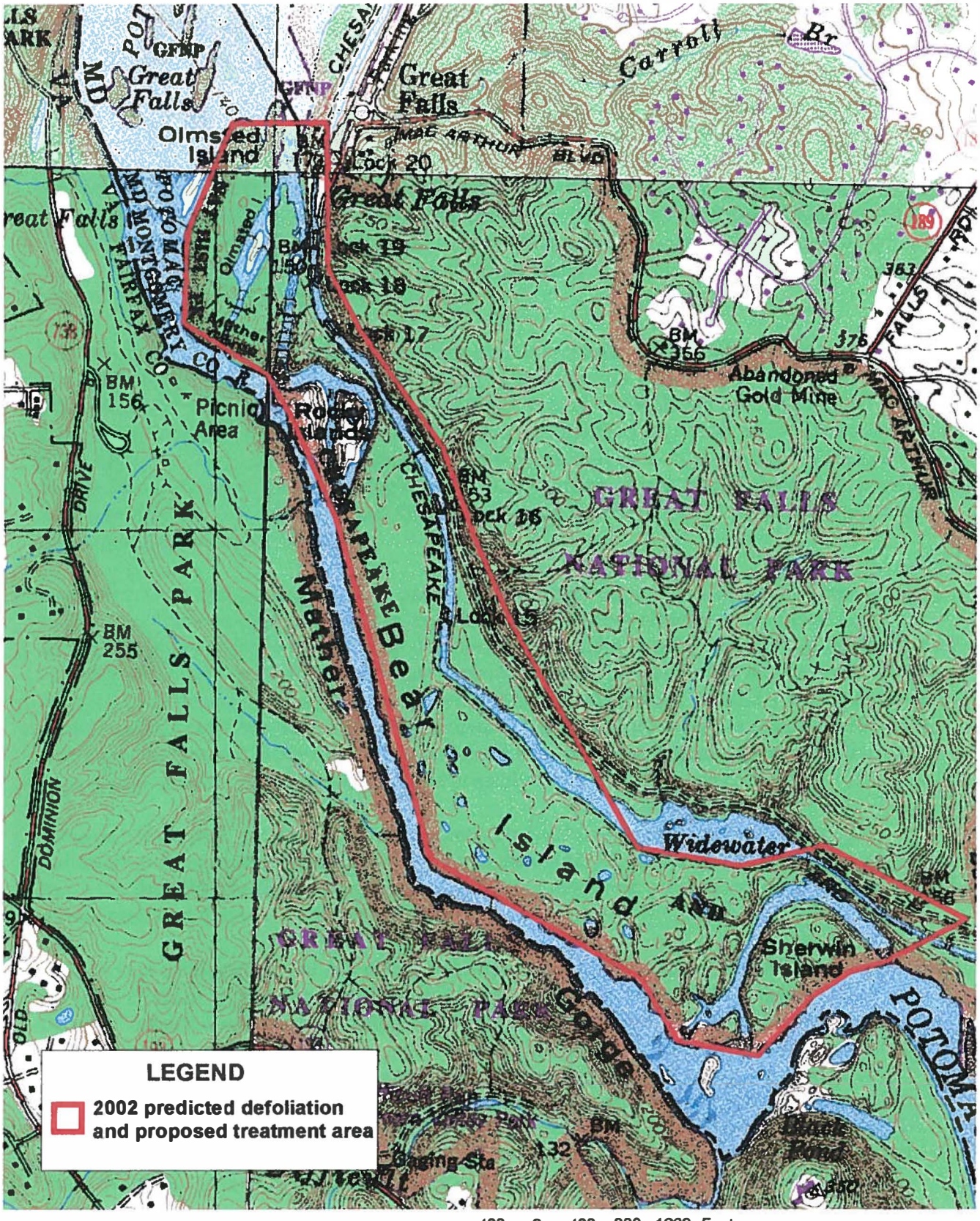
USDA Forest Service, Morgantown, WV 12/01 KDF

Table 1. – Gypsy moth egg mass survey results at
Great Falls National Park on December 5, 2001.

Plot Number	Average em/Acre	Average em length (mm)	% New em
1	80	--	100
2	4,560	30	100
3	8,320	26	82
4	5,400	26	82
5	680	--	100
6	600	34	100
7	120	--	100
8	3,200	36	86
9	5,200	23	86
10	0	--	--

Average egg masses per acre = 2,816
Range of egg masses per acre = 0-8,320
Average length of egg masses = 30 mm

Figure 2.--Area of 2002 predicted defoliation and proposed treatment area (298 acres) at Great Falls National Park.



USDA Forest Service, Morgantown, WV 12/01 KDF

of the mean egg mass length (mm) and egg mass density provides a more precise means of estimating population densities and predicting defoliation. Using Liebhold's model, Figure 3 shows how this information can be used to better assess the potential defoliation at Great Falls NP defoliation is expected to reach 70 percent. This represents an overall average and actual defoliation will vary somewhat from tree to tree throughout the area since egg mass densities and host type are not evenly distributed.

Based on existing egg mass densities and the general size of egg masses, gypsy moth populations within the park appear to be building and healthy. The overall average egg mass length is 30 mm. Egg masses larger than 25 mm typically indicate healthy populations with no obvious stress from either the gypsy moth nucleopolyhedrosis virus (NPV) or the *Entomophaga maimaiga* fungus, two of the primary natural control agents that often express themselves in declining populations. Although it is still possible that either the gypsy moth fungus or the NPV could cause a general collapse of gypsy moth populations, it is unlikely that this would occur prior to a significant defoliation event in 2002.

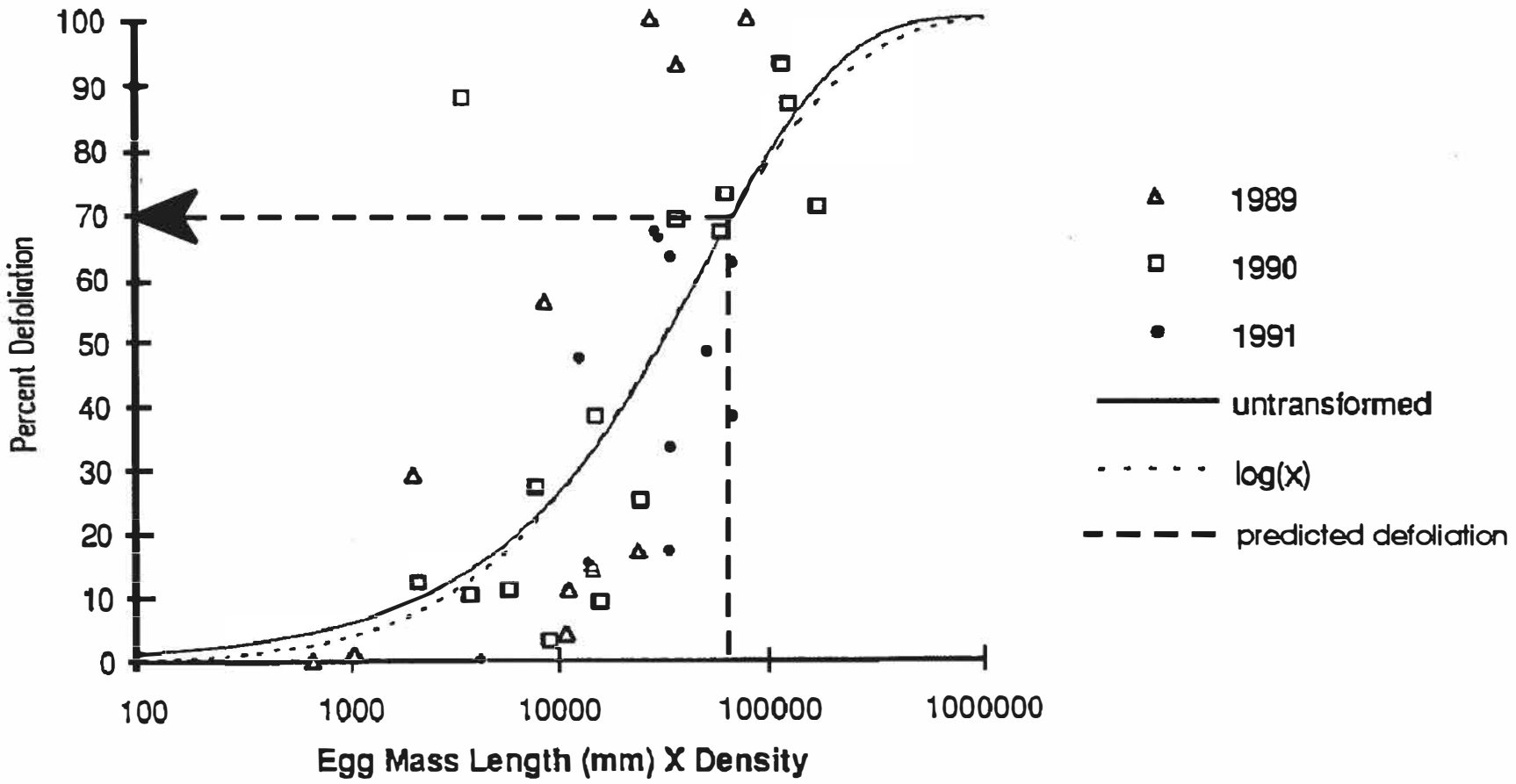
Estimating the risk of tree mortality resulting from defoliation is difficult, however, a stand of trees that is not stressed by other agents during or immediately following a single heavy defoliation will likely pull through with only minor branch dieback and minimal mortality. A more immediate and direct effect of defoliation is through the loss of oak mast. This occurs primarily from caterpillar feeding damage to flowers as well as foliage. Excessive foliage loss causes a lack of carbohydrates, which results in the abortion of immature acorns. It is possible to have several years of complete acorn failure during and following years of moderate to heavy defoliation (Gottschalk, 1990).

In general, trees that are defoliated in excess of 60 percent normally refoliate the same growing season. Such events cause the trees to expend valuable energy reserves to refoliate, and consequently cause the trees' health to deteriorate. Depending on the condition of the trees at the time of defoliation, reduced growth, mast abortion, branch dieback or in some cases tree mortality, has occurred following a single year of heavy defoliation. Should a subsequent year of defoliation occur, the impact is compounded. Trees that receive light-moderate defoliation (< 60 percent) are not likely to refoliate and there is probably no significant impact other than a reduction in growth, reduction of mast and possibly some minor branch dieback.

Trees at greater risk are those that are presently stressed from other factors, such as soil compaction from roads, sidewalks, parking lots, machinery and/or heavy foot travel; over maturity; drought; shock due to recent timber cutting activities; previous year(s) defoliation; and other insect and disease related problems.

Evaluations conducted at the Allegheny National Forest (1988) and in West Virginia by the West Virginia Division of Forestry (1997) provide examples of the potential tree mortality that can occur. Untreated stands on the Allegheny National Forest consisting of 40-80 percent oak, the average loss of basal area (mainly oaks) was about 16 percent (range 3-28) percent) following one year of defoliation and 26 percent (range 10-43 percent) after two consecutive years of defoliation. In a 1986 study area in eastern West Virginia where oak species accounted for 63-78 percent of the species composition, a loss of 25 percent of the total oak sawtimber and 14 percent of the total oak poletimber occurred after one year of moderate to heavy defoliation. In these examples, droughty conditions likely contributed to the level of mortality.

Figure 3.--Predicted defoliation at Great Falls National Park in 2002 based on egg mass length and density.



Scatter plot of the product of mean egg mass length and egg mass density versus mean defoliation. Extracted from Liebhold et al. (1993).

Management Options

For 2002, two management options have been evaluated for managing gypsy moth populations at Great Falls NP. The intervention options are offered based upon the following two treatment objectives: 1) protect host tree foliage to prevent tree mortality; and 2) reduce gypsy moth populations below defoliating levels and subsequent treatment thresholds. Each is discussed below.

No Action Option

It is possible that gypsy moth populations could collapse on their own due to the presence of nucleopolyhedrosis virus (NPV) or the more recently recognized fungal pathogen, *Entomophaga maimaiga.* In areas with defoliating level gypsy moth populations greater than 750 egg masses per acre, viral epizootics often manifest themselves after significant tree defoliation has already occurred. Gypsy moth populations will usually peak in 2-3 years once they reach defoliating levels and then collapse as a result of NPV or fungal activity. Residual populations following such a collapse will likely remain at low densities for 3-6 years before rebuilding to defoliating levels. Although it is not possible to accurately assess such events with the information at hand, it is unlikely that a collapse will occur before defoliation takes place.

Large numbers of gypsy moth caterpillars and defoliation has been show to impact competing native herbivore arthropods. Sample et al. (1996) showed short-term impacts of both species richness and abundance occurred following light to moderate defoliation events in study plots in West Virginia. It is likely that impacts would be greater as the size of the area and intensity of defoliation increases and be more long term, should extensive tree mortality occur.

Should this option be selected, it is likely that heavy defoliation will occur within the survey area at Great Falls NP in 2002.

Microbial Insecticide Option

Btk: The only biological insecticide currently registered and commercially available for gypsy moth control is the microbial insecticide *Bacillus thuringienis* variety *kurstaki (Btk).* This insecticide is available through several manufacturers and has been used extensively in suppression projects throughout the U.S. in both forested and residential areas. *Btk* is a bacterium that acts specifically against lepidopterous larvae as a stomach poison and therefore must be ingested. The major mode of action is by mid-gut paralysis which occurs soon after feeding. This results in a cessation of feeding, and death by starvation. *Btk* is persistent on foliage for about 7-10 days.

Btk has been shown to impact other non-target caterpillars that are exposed of the treatment and are actively feeding. An example of the potential impacts is provided by a study conducted by Miller (1990) in Oregon and Samples, et al. (1996) in West Virginia. Miller's study involved a large-scale eradication program where three consecutive applications of *Btk* were applied to a 5,000 acre treatment block within a single season. On Garry oak, Miller found that species richness was significantly reduced in treated areas during all 3 years of the study while the total number of immature native Lepidoptera rebounded after the second year. In the Sample study, the areas treated with *Btk* were 50 acre plots and only a single treatment applied. Here too, both

species richness and the total numbers of native macro-lepidopterous caterpillars and adults were reduced but only for less than 1-year. The difference in duration of the impacts between these studies is probably the result of the number of applications and the size of the treatment areas.

Btk formulations are available as flowable concentrates, wettable powders, and emulsifiable suspensions. Normal application rates range from 24-36 billion international units (BIUs) per acre in a single or double application. *Btk* can be applied either undiluted or mixed with water for a total volume of ½-1 gallon per acre. With proper application, foliage protection and some degree of population reduction can be expected with one application and with two applications both foliage protection and a greater degree of population reduction are likely. Because *Btk* is a biological insecticide, the degree of population reduction varies and may depend on, at least in part, the selected application rate, relative health of the population (building vs. declining), population densities, weather (rain and temperature), the feeding activity of the larvae following treatment, and the actual potency of the product.

Gypchek: A second microbial insecticide that is registered and available in limited quantities is the formulated nucleopolyhedrosis virus called Gypchek. This product is not available commercially but is produced in limited quantities by a cooperative effort of the USDA Forest Service and the Animal Plant Health Inspection Service (APHIS). The active ingredient in Gypchek formulations has a very narrow host range (lymnatriids) and occurs naturally in gypsy moth populations. Normally the virus reaches epizootic proportions when gypsy moth populations reach high densities as a result of increased transmission within and between gypsy moth generations. The application of Gypchek to gypsy moth populations simply expedites this process by increasing the exposure of the virus at an earlier stage. Healthy, feeding gypsy moth caterpillars become infected by ingesting contaminated foliage and soon stop feeding and die.

The efficacy of Gypchek treatments to reduce gypsy moth populations has been quite variable. Because of the short period of viral activity on foliage (3-5 days) as well as other biological factors such as feeding activity and weather conditions, it has been difficult at best to project treatment efficacy. Most often foliage protection can be achieved but significant reductions in gypsy moth densities do not always occur. Should inadequate population reduction occur, areas may need to be treated again the following year.

The normal application rate of Gypchek is 2×10^{11} occlusion bodies (OB's) per acre applied in two applications, 3-5 days apart. Due to the limited supply, priority is first given to state and federal cooperators that need to deal with federally listed threatened and endangered species associated with gypsy moth treatments. However, there will be sufficient quantities available in 2002 to provide the National Park Service for gypsy moth treatments.

Alternatives

Considering the previously described options and the current status of gypsy moth population in this section of Great Falls NP, the following alternatives are offered.

Alternative 1. -No action

Alternative 2. -One aerial application of *Btk* at the rate of 36 BIUs in a total mix of ¾ gallon per acre.

Alternative 3 - Two aerial applications of *Btk*, as in alternative 2, applied 4-7 days apart.

Alternative 4 -Two aerial applications of Gypchek at the rate of 2×10^{11} OB's in a total mix of 1 gallon per acre, applied 3-5 days apart.

RECOMMENDATIONS

As previously stated, gypsy moth populations at Great Falls are generally healthy, building and sufficient to cause heavy defoliation in 2002. In order to protect tree foliage and prevent subsequent tree mortality, our recommendation is to aerially treat 298 acres as described in either alternative 3 or 4. Either alternative would likely provide foliage protection. Alternative 3 is more likely to significantly reduce gypsy moth populations.

REFERENCES

Allegheny National Forest, Warren, PA. 1988. Gypsy moth caused oak mortality – Allegheny National Forest, 1988. USDA Forest Service internal report prepared by Forest Pest Management staff, Morgantown, WV. Unp.

Gottschalk, K.W. 1990. Gypsy moth impacts on mast production, *In:* McGee, Charles E. Ed. Proceedings of the Workshop, southern Appalachian Mast Management; 1989 August 14-16; Knoxville TN; University of Tennessee; 38-50.

Liebhold, A.M., Simons, E.E., Sior, A., and Unger, J.D. 1993. Forecasting defoliation caused by the gypsy moth from field measurements. Environ. Entomol. 22(1): 26-32.

Miller, J.C. 1990. Field assessment of the effects of a microbial pest control agent on non-target Lepidoptera. American Entomologist 36:2, 135-139.

Moore, K.E.B. and Jones, C.G. 1987. Field estimation of fecundity of gypsy moth (Lepidoptera:Lymnatriidae). Environ. Entomol. 16: 165-167

Sample, B.E., Butler, L., Zivkovich, C., Whitmore, R.C., and Reardon, R.C. 1996. Effects of *Bacillus thuringiensis* Berliner var. *Kurstaki* and defoliation by gypsy moth [*Lymantria dispar* (L.) (Lepidoptera:Lymnatriidae)] on native arthropods in West Virginia. The Canadian Entomologist 128:573-592.

West Virginia Division of Forestry. 1997. *In* 1997 Cooperative State-County-Landowner Gypsy Moth Suppression Program in West Virginia. 3p. (Brochure).

United States Department of Agriculture | Forest Service | Northeastern Area State & Private Forestry | 180 Canfield Street Morgantown, WV 26505-3101

File Code: 3400
Date: December 10, 2001

Ms. Jil Swearingen
Entomologist
NPS National Capital Region
Center for Urban Ecology
4598 Mac Arthur Boulevard
NW Washington, DC 20007

Dear Ms. Swearingen: C&O Canal NHP - Great Falls Area

Enclosed is a gypsy moth biological evaluation for Great Falls National Park conducted on December 5, 2001.

In brief, gypsy moth populations at Great Falls NP (298 acres) are sufficient to cause heavy defoliation in 2002. In order to protect foliage and prevent subsequent tree mortality, our recommendation is to aerially apply either two applications of *Bacillus thuringienis* variety *kurstaki (Btk)* at the rate of 36 BIU's per acre or two applications of Gypchek at the rate of 2 x 10^{11} OB's in a total mix of 1 gallon per acre.

If you have any question concerning the biological evaluation, please feel free to call Brad Onken at (304) 285-1546 or Karen Felton at (304) 285-1556.

Sincerely,

JOHN W. HAZEL
Field Representative
Morgantown Field Office

Enclosure

Cc: Susan Alberts, C&O Canal
Robert Tichenor, MDA
Betsie Handley, MDA
Noel Schneeberger, AO
Bernie Raimo, DFO, FHP
Mike Connor, SPFO, FHP

Karen